

## SEX- AND SPECIES-SPECIFIC GROWTH PATTERNS IN CRYPTIC AFRICAN RODENTS, *MASTOMYS NATALENSIS* AND *M. COUCHA*

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The sibling multimammate mice, *Mastomys natalensis* and *M. coucha*, occur throughout southern Africa, exhibiting limited sympatry. We examine body mass and growth characteristics of both species, from birth to 26 weeks of age. Gompertz growth curves were fitted to data for body mass and lengths of head and body, tail, hind foot, and ear. Males of both species exhibited greater asymptotic values, faster maximum growth rates, later age of maximum growth, and extended growth periods than females. However, neither species established body mass dimorphism before weaning, suggesting that differential maternal investment between sexes is not important in preweaning growth. Furthermore, *M. natalensis* exhibited significantly faster maximum growth rates to reach a greater predicted asymptotic mass than *M. coucha*. We discuss these results in relation to mating system and interspecific competition.

Key words: allometry, exclusion, Gompertz, growth, *Mastomys coucha*, *Mastomys natalensis*, Muridae, rodent

Body size dimorphism has important behavioral and ecological implications at both intra- and interspecific levels. At an intraspecific level, overt male–male conflict for mates will select for large body size in males, and mammals exhibiting marked male–female body size dimorphism are generally characterized by polygynous breeding systems with a high degree of male reproductive variability (Andersson 1994). Thus, for many mammals the degree of sexual size dimorphism can be related to male mate competition.

At an interspecific level, body size dimorphism may help shape local community assemblages. Theoretical considerations underlying these mechanisms, including character displacement (Brown and Wilson 1956; Dayan and Simberloff 1998) and limiting similarity (Hutchinson 1959), should reduce interspecific competition, although differentiating between these factors and in-

dependence between species has proved to be problematic (Simberloff and Boecklen 1981; Strong et al. 1979). Thus, limiting similarity has been suggested as a mechanism structuring granivorous rodent assemblages in North American deserts (Bowers and Brown 1982; Dayan and Simberloff 1994). However, simulations examining the coevolution of 2 competing species suggest character displacement to be the least frequent and competitive exclusion the most frequent outcome (Kawata 1996). Thus, for closely related species with similar ecological requirements, differences in body size should have a profound influence on interspecific competition and species distribution.

The African multimammate mouse genus (*Mastomys*) comprises several species showing little morphological separation, despite marked karyotypic differentiation (Britton-Davidian et al. 1995). Of these, *Mastomys natalensis* is the most abundant

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rodent of sub-Saharan Africa (Fiedler 1988). Throughout much of its range *M. natalensis* occurs in association with other species in the *Mastomys* complex, including *M. huberti* (= *M. hilderbrandtii*—Musser and Carleton 1993) in Senegal (Duplantier et al. 1996), *M. erythroleucus* in Ethiopia (Lavrenchenko et al. 1998), and *M. coucha* in southern Africa (Dippenaar et al. 1993). Limited data are available regarding interactions between *M. natalensis* and these species. In western Africa, Granjon and Duplantier (1993) suggested that *M. natalensis* is more aggressive than either *M. huberti* or *M. erythroleucus*. Otherwise, the relative distribution of *Mastomys* in Senegal has been explained by differences in reproductive performance, allowing certain species to colonize new habitats faster than others (Duplantier et al. 1996).

Although differences in diploid number of *Mastomys* species within southern Africa were identified in the 1960s (Matthey 1966), *M. natalensis* ( $2n = 32$ ) was only functionally distinguished from its sibling species *M. coucha* ( $2n = 36$ ) in the 1970s (Gordon 1984; Green et al. 1980), in relation to bubonic plague epidemiology. Differences can also be detected through gel electrophoresis (Green et al. 1980; Smit et al. 2001) or the use of molecular techniques (Cheveret et al. 1994). Morphologically, however, these species are difficult to separate in the field, and Gordon (1984) was unable to distinguish any differences in their mass or external characteristics. Multivariate morphometric analysis of skull measurements separates these rodents (Dippenaar et al. 1993), although the technique cannot be applied to wide-ranging field localities (Njobe 1997).

*Mastomys coucha* is known to occur over a wide variety of habitats (Avenant 1997), where it can dominate rodent communities (Avenant 2000). Rainfall is an important determinant of distributional patterns of these 2 species, with *M. natalensis* generally occurring in areas receiving >600 mm annual rainfall and *M. coucha* in drier areas

with an annual precipitation of <700 mm (Gordon 1984). The 2 species occur sympatrically within the 600–700 mm rainfall isohyets. These data suggest that *M. natalensis* may not be able to tolerate the less mesic areas of the region. However, the absence of *M. coucha* from the wetter areas is unclear, although competitive exclusion could be involved.

In this study, we examine patterns of growth of the cryptic *M. natalensis* and *M. coucha*, using captive-born animals under controlled laboratory conditions. Given the likelihood of interspecific competition, certainly within the more mesic areas of southern Africa, we hypothesize that adult body mass of *M. natalensis* may be greater than that of *M. coucha*, giving it a competitive advantage. We also consider the implications of any intraspecific sexual size dimorphism.

#### MATERIALS AND METHODS

*Maintenance and measurement of individuals.*—We conducted all experiments under controlled laboratory conditions (25°C, photoperiod 14L:10D) at the University of Pretoria, South Africa. The ethical committee of the Faculty of Natural and Agricultural Sciences of the University sanctioned all holding and handling procedures. Captive breeding pairs of *M. natalensis* were established from 20 adult males and 20 females captured at Richards Bay (28°43'S, 32°12'E), KwaZulu-Natal, South Africa, and similar numbers of *M. coucha* were captured at Pretoria (25°45'S, 28°14'E), Gauteng, South Africa. We confirmed the species status of individuals by starch gel protein electrophoresis (G. Campbell, pers. comm.). Commercial mouse pellets (Epol Animal Feed Manufacturers, Pretoria, Gauteng, South Africa) and water were provided ad lib. In addition, animals were provided with fresh sawdust bedding and plastic shelters.

Following the protocol of Lamb and van Aarde (2001), we removed litters produced by these wild-caught pairs at weaning age (21 days—Meester 1960) and fed them mouse pellets ad lib until they were 50 days old. As the earliest recorded 1st estrous cycle for *Mastomys* is 54 days (Meester 1960), offspring were randomly

paired (not with siblings) at this age. Animals received 10 g/day of food pellets containing an optimal digestible protein content of 15% and a digestible energy content of approximately 123 kJ—sufficient energy for growth and reproduction (Perrin and Clarke 1987). We established 10 breeding pairs for both species.

The 2nd litter of each breeding pair was used in growth trials, and breeding pairs were checked every 24 h for new litters. Thus, for all litters we initially measured infants within 24 h of birth. Only 2 randomly selected males and 2 females from each litter were kept with the breeding pair to minimize the possible effect of litter size on growth rates to weaning (e.g., Kam and Degen 1994). At 21 days, litters were weaned, transferred to their own cage, and placed on the 15% protein diet as described above. These young were divided into male and female groups of four individuals each at 50 days of age to ensure that female measurements were not complicated by pregnancy, and to control for density effects.

We measured infants at partum and then on a daily basis until weaning at 21 days. Post-weaning measurements were made on a weekly basis until 26 weeks (182 days) of age, during which time measurements were stopped as provisional growth curves suggested that individuals had attained asymptotic growth. We measured body mass, head–body length, tail length, hind foot length, and ear length. Body mass was measured to the nearest 0.01 g using an electronic balance (Ohaus Precision Advanced Balance, Pine Brook, New Jersey) and lengths to the nearest 0.1 mm using digital calipers (Mitutoyo Corp., Kawasaki, Japan). For each data point, we used the mean measurements for the 2 males and females of each litter in the final analysis.

*Growth rate models.*—We fitted data to a 3-parameter Gompertz model (cf. Begall 1997; Zullinger et al. 1984), using the following formula:  $m(t) = Ae^{-e^{-K(t-I)}}$ , where  $m(t)$  = body measurement at time  $t$ ,  $A$  = asymptotic size,  $K$  = growth constant (per day), and  $I$  = inflection point (days). Using these parameters, the maximum growth rate ( $AKe^{-1}$ ), at the inflection point for which growth rate is fastest, was also calculated.

Although several different curves may have been fitted to the data (e.g., Richards, logistic, and van Bertalanffy), the Gompertz was chosen

because it provided a better fit to the data for both study species than either Richards or logistic model. It is also the most widely used growth curve for rodents (e.g., Begall and Burda 1998; Lammers et al. 2001; Scharff et al. 1999), providing a number of growth parameters that may readily be compared with other rodent studies. We fitted data for males and females from each litter to growth curves by non-linear regression, using the Levenberg–Marquardt method to minimize the residual sum-of-squares model (GraphPad Prism 3.00, GraphPad Software, San Diego, California). Subsequently, we examined the effects of species and sex on growth parameters by 2-way analysis of variance (ANOVA—Zar 1996). Analyses were conducted using Statistica 5.0 (StatSoft, Inc., Tulsa, Oklahoma).

## RESULTS

*Interspecific growth and size dimorphism.*—Body mass, head–body length, tail length, and hind foot length did not differ significantly between species at birth (Table 1; Figs. 1 and 2). Ear length was approximately 1 mm longer in *M. coucha* than in *M. natalensis* and continued to be so at 6 months of age (Table 1; Fig. 2). By weaning, however, all measured variables except head and body lengths were significantly greater for *M. natalensis* (Table 1), and by the age of 6 months *M. natalensis* was larger than *M. coucha*, with the exception of ear length (Table 1). At this age, the average body mass of male *M. natalensis* was 13.9% and for females 15.8%, greater than that of *M. coucha*.

The growth parameters derived from Gompertz equations for body mass (Table 2; Fig. 1) demonstrated that *M. natalensis* developed at a greater maximum growth rate (maximum growth rate:  $F = 22.6$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; Table 2) to reach a greater predicted asymptotic mass (asymptotic mass:  $F = 4.6$ ,  $d.f. = 1, 35$ ,  $P < 0.05$ ; Table 2) than *M. coucha*.

Similarly, parameter estimates derived from Gompertz equations for external morphometrics during growth showed that growth rates and almost all asymptotic val-

TABLE 1.—Sex and species-specific differences in body size for 10 male and 10 female southern African *Mastomys natalensis* and *Mastomys coucha* at birth, weaning (21 days old), and 6 months of age; *d.f.* = 1, 35 for all ages.

	<i>Mastomys natalensis</i>				<i>Mastomys coucha</i>				<i>F</i> -values and probabilities			
	Male		Female		Male		Female		Species		Sex	
	$\bar{X}$	<i>SE</i>	$\bar{X}$	<i>SE</i>	$\bar{X}$	<i>SE</i>	$\bar{X}$	<i>SE</i>	<i>F</i>	<i>P</i>	<i>F</i>	<i>P</i>
Body mass (g)												
Birth	2.2	0.1	2.1	0.1	2.0	0.1	2.1	0.1	0.9	0.344	0.0	0.860
Weaning	10.2	0.3	9.7	0.3	8.1	0.6	8.3	0.4	18.7	<0.0002	0.1	0.727
6 months	51.5	3.7	37.3	1.6	45.2	2.5	32.2	3.1	5.1	0.031	24.2	<0.0001
Head and body length (mm)												
Birth	33.1	0.6	32.2	0.6	32.1	0.7	31.7	0.4	1.4	0.242	1.2	0.289
Weaning	65.5	0.9	65.1	1.1	65.4	2.1	63.4	1.7	2.5	0.126	0.0	0.904
6 months	114.3	1.4	107.0	1.4	106.2	1.3	96.7	2.1	37.1	<0.0001	39.1	<0.0001
Tail length (mm)												
Birth	13.7	0.6	13.4	0.4	12.8	0.3	12.7	0.4	3.2	0.083	0.3	0.594
Weaning	55.6	1.1	55.1	1.2	41.5	1.6	42.8	1.7	88.6	<0.0001	0.1	0.755
6 months	96.5	2.2	88.6	2.9	81.1	1.3	75.6	1.5	48.6	<0.0001	10.7	0.003
Hind foot length (mm)												
Birth	6.4	0.2	6.5	0.2	6.3	0.2	6.5	0.1	0.0	0.837	0.7	0.400
Weaning	18.6	0.2	18.2	0.1	17.0	0.5	17.0	0.4	20.3	<0.0001	0.3	0.563
6 months	23.0	0.2	22.1	0.1	21.2	0.2	20.5	0.3	88.5	<0.0001	23.3	<0.0001
Ear length (mm)												
Birth	2.3	0.2	2.2	0.2	3.0	0.1	3.2	0.2	27.5	<0.0001	0.0	1.000
Weaning	11.7	0.2	11.4	0.3	10.9	0.4	11.0	0.3	4.2	0.049	0.3	0.609
6 months	15.1	0.2	14.7	0.2	15.8	0.4	15.7	0.3	9.0	0.005	1.0	0.325

ues were greater for *M. natalensis*. Thus, maximum growth rate of head and body ( $F = 30.4$ , *d.f.* = 1, 35,  $P < 0.0001$ ) and asymptotic length ( $F = 34.9$ , *d.f.* = 1, 35,  $P < 0.0001$ ; Table 2; Fig. 2) were greater. So too were maximum growth rate of tail ( $F = 133.0$ , *d.f.* = 1, 35,  $P < 0.0001$ ) and asymptotic length ( $F = 147.9$ , *d.f.* = 1, 35,  $P < 0.0001$ ; Table 2; Fig. 2) as well as maximum growth rate of hind foot ( $F = 8.2$ , *d.f.* = 1, 35,  $P < 0.01$ ) and asymptotic length ( $F = 187.4$ , *d.f.* = 1, 35,  $P < 0.0001$ ; Table 2; Fig. 2). However, although predicted maximum ear growth rates were greater for *M. natalensis*, the predicted asymptotic ear lengths did not differ significantly between species (maximum growth rate:  $F = 20.5$ , *d.f.* = 1, 35,  $P < 0.0001$ ; asymptotic length:  $F = 0.9$ , *d.f.* = 1, 35,  $P = 0.36$ ; Table 2; Fig. 2).

The inflection age (*I*) at which maximum

growth rates were achieved by *M. natalensis* was later than that of *M. coucha* for head and body as well as hind foot length (Table 2). The inflection ages did not, however, differ significantly for other parameter estimates, including body mass, tail length, and ear length (Table 2).

*Intraspecific growth and sexual size dimorphism.*—Significant sex-specific differences in weight and external body measurements were not present at birth (Table 1; Figs. 1 and 2) and had not developed by the time animals were weaned (Table 1), although highly significant sex-specific differences had developed by the time individuals were 6 months (182 days) old for all measured variables except ear length (Table 1). Thus by 6 months, male *M. natalensis* was on average 38.1% heavier and male *M. coucha* was 40.4% heavier than females.

When data were fitted to Gompertz

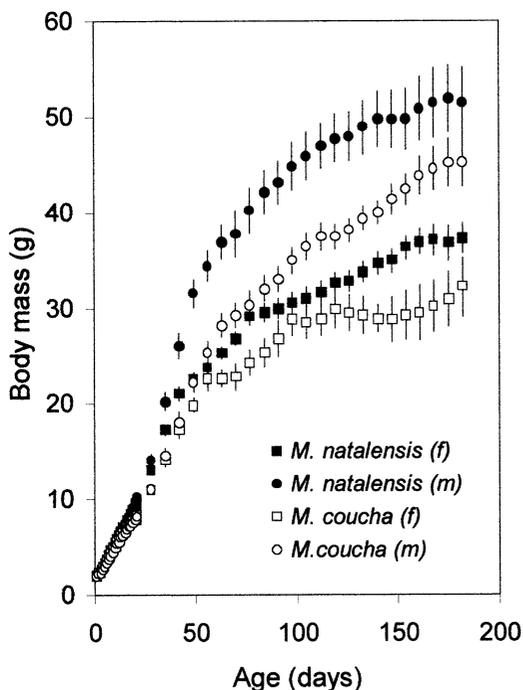


FIG. 1.—Body mass (mean  $\pm$  SE) of male (m) and female (f) southern African *Mastomys natalensis* ( $n = 10$ ) and *Mastomys coucha* ( $n = 10$ ) litters from birth until 26 weeks (182 days) of age.

growth curves, both species showed significant sex-specific differences in growth parameters (Table 2; Figs. 1 and 2). Thus, males had a significantly faster maximum predicted growth rate (maximum growth rate:  $F = 27.7$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; Table 2; Fig. 1) to reach a greater predicted body mass (asymptotic mass:  $F = 34.7$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; Table 2; Fig. 1) than females. Males were, however, older at the time when maximum growth rates were attained (inflection age:  $F = 12.1$ ,  $d.f. = 1, 35$ ,  $P < 0.002$ ; Table 2; Fig. 1).

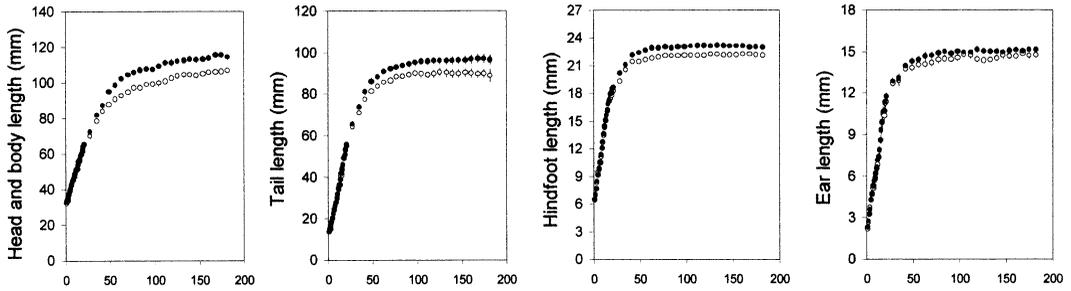
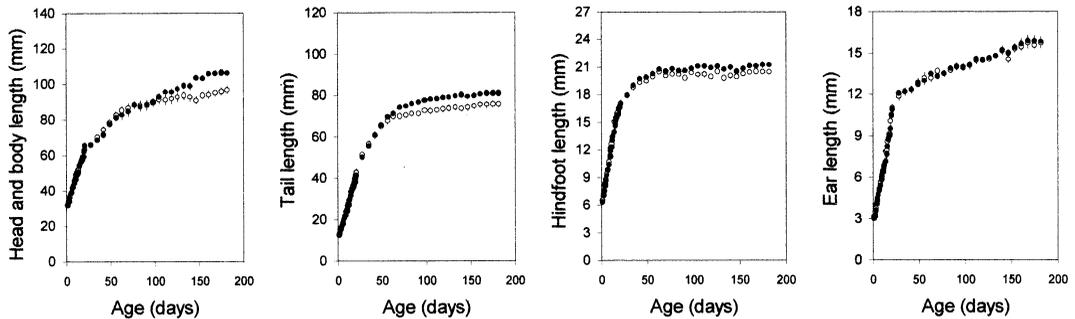
Sex-specific differences in growth-related parameter estimates were noted for all variables except ear length (Table 2; Fig. 2). Thus, females were smaller than males, as predicted by their asymptotic measurements (head body length:  $F = 20.1$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; tail length:  $F = 23.1$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; hind foot length:  $F = 34.8$ ,

$d.f. = 1, 35$ ,  $P < 0.0001$ ; ear length:  $F = 2.6$ ,  $d.f. = 1, 35$ ,  $P = 0.11$ ). Females also attained maximum growth rates at an earlier age than males (inflection point for head-body length:  $F = 56.0$ ,  $d.f. = 1, 35$ ,  $P < 0.0001$ ; tail length:  $F = 18.0$ ,  $d.f. = 1, 35$ ,  $P < 0.0002$ ; hind foot length:  $F = 4.4$ ,  $d.f. = 1, 35$ ,  $P < 0.05$ ; ear length:  $F = 1.3$ ,  $d.f. = 1, 35$ ,  $P = 0.27$ ; Table 2). The predicted maximum growth rates, however, did not differ significantly between sexes (head-body length:  $F = 2.6$ ,  $d.f. = 1, 35$ ,  $P = 0.12$ ; tail length:  $F = 1.2$ ,  $d.f. = 1, 35$ ,  $P = 0.29$ ; hind foot length:  $F = 0.4$ ,  $d.f. = 1, 35$ ,  $P = 0.52$ ; ear length:  $F = 1.3$ ,  $d.f. = 1, 35$ ,  $P = 0.27$ ; Table 2).

#### DISCUSSION

Growth rates for both *Mastomys* species were typical of many rodents, with males showing greater asymptotic values, faster maximum growth rates, later age of maximum growth, and extended growth periods than females (Begall and Burda 1998; Lima et al. 1997; Yoshinaga et al. 1997). Unlike previous studies (Baker and Meester 1977; Meester 1960), we recorded a maximum rate of increase in body mass for *M. natalensis* after weaning at approximately 30 days of age (see Table 2), whereas others have reported the greatest increase in mass in the 1st few days after birth. However, their observations only continued for 30 and 40 days, respectively, from birth, during which time infants remained housed with their parents.

As with many rodents (Boutin and Larsen 1993; Derrickson 1988; Kam and Degen 1994), neither *Mastomys* species exhibited intraspecific dimorphism in body mass before weaning. For *M. coucha*, not only are sexes similar in body mass but even maternal energetic allocations also are comparable, with males and females maintaining similar fat and protein contents from birth to weaning (Lamb and van Aarde 2001). Together, these findings suggest that differential maternal investment between sexes is not important in the preweaning

*Mastomys natalensis**Mastomys coucha*

HEAD AND BODY

TAIL

HINDFOOT

EAR

FIG. 2.—Lengths (mean  $\pm$  SE) of head and body, tail, hind foot, and ear recorded for male ( $\bullet$ ) and female ( $\circ$ ) southern African *Mastomys natalensis* ( $n = 10$ ) and *Mastomys coucha* ( $n = 10$ ) litters from birth until 26 weeks (182 days) of age.

growth of the *Mastomys* species examined in our study.

Sexual size dimorphism was established through the longer growth periods and later timing of maximum growth recorded for males in the postweaning period and not through faster growth. Several *Mastomys* species have been shown to exhibit sexual dimorphism in body mass (Chapman et al. 1959; Rogers-Brambell and Davis 1941), including *M. natalensis*, which displays both earlier and more pronounced sexual dimorphism at an adult age than the congeneric species, *M. huberti* and *M. erythroleucus* from Senegal (Granjon and Duplantier 1993).

Despite differences in asymptotic sizes of males, the degree of sexual size dimorphism was comparable for both *M. natalensis* and *M. coucha*. We suggest that such

a sexual size dimorphism is associated with a polygynous breeding system, as has been described for several other sexually dimorphic rodents (Boonstra et al. 1993; Sachser et al. 1999; Yoshinaga et al. 1997).

The differences we recorded in body mass between *M. coucha* and *M. natalensis* are well within the limits of Hutchinson's rule of size ratios (Hutchinson 1959), suggesting that there should be interspecific competition in areas where both species occur sympatrically. Only through some segregation mechanism such as microhabitat use (e.g., du Plessis and Kerley 1991), diet, or time allocation (Kronfeld-Schor and Dayan 1999) could such competition be reduced. However, in all likelihood, the diets and refuge strategies of both these nocturnal species are similar. *M. natalensis* is known to feed on a variety of food mate-

TABLE 2.—Growth parameter estimates for body mass, head and body, tail, hind foot, and ear ( $\bar{X} \pm SE$ ) and the coefficients of determination derived for Gompertz growth curves for male and female southern African *Mastomys natalensis* and *Mastomys coucha*. Differences between species and sex tested using 2-way ANOVA.

	<i>Mastomys natalensis</i>				<i>Mastomys coucha</i>				F-values and probability levels		
	Male		Female		Male		Female		Species	Sex	Species $\times$ sex
	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE			
<b>Body mass</b>											
Asymptotic mass (A; g)	50.6	0.3	35.7	0.4	44.2	0.5	30.3	0.3	4.6*	34.7***	0.6
Inflection age (I; days)	32.9	0.5	29.1	0.8	39.3	0.9	27.2	0.6	2.1	12.1**	2.6
Maximum growth rate (KAe <sup>-1</sup> ; g day <sup>-1</sup> )	0.67		0.43		0.44		0.39		22.6***	27.7***	8.9**
Growth constant (K; day <sup>-1</sup> )	0.036	0.001	0.033	0.001	0.027	0.001	0.035	0.002			
r <sup>2</sup>	0.998		0.994		0.996		0.996				
<b>Head and body length</b>											
Asymptotic body length (A; mm)	113.5	0.3	104.0	0.4	102.7	1.5	92.9	0.5	34.9***	56.0***	0.5
Inflection age (I; day)	6.4	0.2	3.9	0.3	1.7	1.0	1.3	0.4	13.7***	20.1***	0.1
Maximum growth rate (KAe <sup>-1</sup> ; mm day <sup>-1</sup> )	1.61		1.53		1.01		1.42		30.4***	2.6	8.2**
Growth constant (K; day <sup>-1</sup> )	0.039	0.001	0.040	0.001	0.027	0.002	0.042	0.002			
r <sup>2</sup>	0.999		0.997		0.979		0.994				
<b>Tail length</b>											
Asymptotic tail length (A; mm)	95.8	0.2	89.5	0.2	79.2	0.4	70.1	0.3	147.9***	23.1***	0.0
Inflection age (I; day)	12.2	0.1	11.0	0.1	12.4	0.3	11.7	0.2	3.1	18.0***	1.7
Maximum growth rate (KAe <sup>-1</sup> ; mm day <sup>-1</sup> )	2.16		2.14		1.41		1.44		133.0***	1.2	1.5
Growth constant (K; day <sup>-1</sup> )	0.061	0.001	0.065	0.001	0.048	0.001	0.056	0.001			
r <sup>2</sup>	0.999		0.999		0.996		0.997				
<b>Hind foot length</b>											
Asymptotic hind foot length (A; mm)	23.0	0.0	22.1	0.1	20.7	0.1	20.2	0.1	187.4***	34.8***	0.8
Inflection age (I; day)	4.0	0.1	3.5	0.1	3.0	0.2	2.8	0.2	14.5***	4.4*	0.2
Maximum growth rate (KAe <sup>-1</sup> ; mm day <sup>-1</sup> )	0.78		0.78		0.7		0.7		8.2**	0.4	0.3
Growth constant (K; day <sup>-1</sup> )	0.092	0.001	0.097	0.002	0.095	0.002	0.094	0.002			
r <sup>2</sup>	0.999		0.998		0.995		0.996				
<b>Ear length</b>											
Asymptotic ear length (A; mm)	14.9	0.1	14.5	0.1	14.6	0.1	14.5	0.1	0.9	2.6	0.5
Inflection age (I; day)	8.0	0.2	7.7	0.2	8.5	0.5	7.1	0.5	1.0	1.3	0.2
Maximum growth rate (KAe <sup>-1</sup> ; mm day <sup>-1</sup> )	0.50		0.50		0.28		0.37		20.5***	0.0	0.1
Growth constant (K; day <sup>-1</sup> )	0.091	0.002	0.094	0.003	0.051	0.004	0.069	0.004			
r <sup>2</sup>	0.996		0.995		0.986		0.979				

\* P < 0.05, \*\* P < 0.01, \*\*\* P < 0.001.

rials, including seeds, insects, and grasses, whose consumption is subject to seasonal availability (Field 1975; Oguge 1995). Unfortunately, no similar data are available for *M. coucha*.

If body mass is an important consideration in interspecific competition, the larger size of *M. natalensis* over *M. coucha* should allow a competitive advantage in encounters. Density-dependent effects, including reproductive suppression and competition for resources such as food, become more important late in the breeding season, and density-dependent mechanisms controlling population growth have been demonstrated for *M. natalensis* in eastern Africa (Leirs et al. 1997).

The potential ability of *M. natalensis* to compete favorably with *M. coucha* may be enhanced by its ability to breed under conditions of lower food quality, as Jackson and van Aarde (in litt.) have demonstrated. This would allow the former species to initiate breeding earlier within the season which, together with the differences in growth rates recorded in the present study, should enhance its competitive advantage over *M. coucha*.

The breeding and growth data for these 2 *Mastomys* species suggest that interspecific competition could contribute to their distributional patterns. Significantly, their distributions show little overlap, with rainfall playing a critical role (Gordon 1984). Indeed, *M. natalensis* may not be able to tolerate conditions in the less mesic areas of southern Africa. However, the absence of *M. coucha* from the wetter areas is unclear, although a likely explanation would be interspecific competition. Our data provide an insight into aspects of species-specific growth rates that may contribute to such a mechanism.

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#### LITERATURE CITED

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